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Atmospheric Measurement Techniques Discussions

Interactive comment on "Relative drifts and biases between six ozone limb satellite measurements from the last decade" *by* N. Rahpoe et al.

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Interactive Comment

Final Response to Referee 2

N. Rahpoe

30 July 2015

Abstract

We would like to thank the Anonymous Referee 2 for their effort to carefully read the paper and giving us valueable comments to improve the paper.

0.0.1 1.)Please provide more information in the Introduction on other merging activities and therein derived information on possible instrument drifts. SI2N is not mentioned at all.

We now added reference to SI2N and merging activities in the Introduction part.

0.0.2 2.) Be consistent with the kind of information provided in Section 2. Characteristics like satellite orbit, horizontal resolution, estimated uncertainty and others are given for one or two instruments only.

We now changed those inconsistencies and added general information about orbits, Local Time and etc for all satellites in Section 2.

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Interactive Discussion
Discussion Paper

'The six instruments used for the comparison in this work are carried by three different satellites. Three atmospheric chemistry experiments (GOMOS, MIPAS, and SCIAMACHY) are on board the Envisat satellite operated from 2002 to 2012. It flew in a sun-synchronous orbit at altitude of 780 km leading to an orbital period of $\approx$ 100 min and 14 orbits per day. OSIRIS and SMR aboard Odin are two instruments taking measurements since 2001 and are still operating. Odin circles the Earth in a polar, sun-synchronous, near-terminator orbit with an inclination of 97.8 degree at an altitude of 600 km. ACE-FTS provides measurements since 2004 on SCISAT that has a circular orbit with an inclination of 74 degree at an altitude of 650 km'.

A table is added (Table 1) to highlight the estimates of uncertainty and other informations for all instruments.

0.0.3 3.) Section 3: Provide information (here or later in the manuscript) on how sensitivie your results are on the collocation criteria

We added a short paragraph in Sect. 5.1 to explain the possible impact of local time differences on the results.

'The difference in local time of measurement can have an impact on the differences in the collocated ozone profiles. Following Studer et al. 2013 the diurnal variation has the largest impact above 50 km with its difference between night time and day time of up to ± 20 %. This might explain the variability observed in the relative biases at 50 km but can not explain the significant relative biases observed for the altitudes below 50 km where the differences in the local time are expected to have less than ± 5 % impact on the differences in ozone. We conclude that the variability observed in the biases is intrinsical and instrument dependent and not based on the differences in the local time.'

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0.0.4 4.) Basic information on the ozone data sets are missing. What is the vertical grid and coordinate used? If the data sets were transformed between altitude and pressure grid and between mixing ratios and concentration provide the relevant information on the methods

Table 1 is added to give all information of the instruments regarding native grid and ozone units. The comparison unit for all data sets is vmr on a 1 km grid. This information has been added in Section 3.

0.0.5 5.) Over which time period and grid are the mean relative differences defined?

This information is added in Table 1.

0.0.6 6.) Equation 6 is not correct since the error variable is missing.

There is no Equation 6.

0.0.7 7.) I am confused with section 4.1 and Figs 1-3. Why are the time series shown in the Figures if only absolute errors (averaged over time) are discussed in the text. The Figures show only a comparison of SCIAMACHY to the other instruments, but the text reads at various places like it would be based on a comparison between all instrument, e.g., '.....best agreement between all data sets....'. Line 1: Above 30 km, the differences are higher than 10 %.

In Figs. 1-3 the mean realitve differences (MRD in %) are shown, and in the text only the MRDs are discussed and not the errors.

We replaced the sentence '*best agreement between all data sets...*' by '*.....at 25 km*

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SCIAMACHY is lower than most of the other instruments, but all instrument agree to within $\pm 5\%$*.....'*

0.0.8 8.) Last sentence of section 5 (page 3709, line 23-23): Is SMR really the only exception? What is for instance with MIPAS at 45 km in the SH midlatitudes? Figures 5-10 are very hard to read. Maybe you could consider showing the significant drifts only? Or using larger symbols for significant drifts? At the moment it is not clear from the Figures which biases or drifts are significant.

The drift values generally changed as we now account for autoregression (see Reviewer 1). Now there is no exception in case of significant drifts for SMR. We now replaced the error plots by figures showing significant relative bias and drift values and shading out the insignificant values (Fig. 4-9). In addition the distance between the plotted instrument lines are increased to make it the plots easier to read.

0.0.9 9.) Regarding the comparison with other validation studies, please provide if and how the other two studies use a different methodolgy. Would you expect different results than Eckert et al.? How do your results of mean relative differences compare to other studies that are not based on pairwise collocated measurements? Such information is important to understand the possible advantages of your method.

We have added a brief information regarding the methods and units applied in Section 5.2:

'The methods applied here differs in the manner, that we used the mean relative differences, which is not sensitive to outliers in the denominator if only single profiles is used. The drifts given by Eckert et al. 2014 is based on the absolute differences and not on relative. Adams et al. 2013 gives the drifts by using a robust method of the

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median values which is comparable to our method. Other advantage is that the same method, ozone unit, and gridding is applied to all 15 pairs here. Other validation works are based on few pairs mainly from the prespective of a single comparison sensor. A caveat to all methods is that non-linearity effects in biases and drifts can have an impact on the final derived parameters'.

0.0.10 10.) Discuss the implications of your results for the CCI merging activity, e.g., should the statistically insignificant drifts be ignored when creating essential climate variable records?

We added now a concluding remark on how we think the errors on trend analysis can be interpreted from our drift and bias analysis. Since most of the drifts does not show any significant drifts we can calmly merge the data sets by excluding data points of a reference sensor which show significant drift with respect to majority of instruments. In addition we recommend that the uncertainties for the trend analysis in other works should be extended by the drift values given in this paper for different instruments.

- Exlusion of significant drift data points.
- The added drift uncertainty is estimated at about 3$\%\, decade^{-1}$ (1σ)

This text has been added at the end of Section 5 and the Conclusion: *'The evaluation of relative biases and relative drifts between pairwise sensors demonstrates its value in understanding the differences between the sensors and differences of the derived trends and can be used to estimate the added uncertainty in physical trends from the drift. The added drift uncertainty is estimated at about 3*$\%\, decade^{-1}$ *(1*σ*).'*

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